1990 - 2010: CUTEC 20 YEARS ON

CUTEC-News

ANNIVERSARY EDITION

20 YEARS CUTEC:

CONGRATULATIONS FROM LOWER SAXONY MINISTER PRESIDENT CHRISTIAN WULFF

Lower Saxony Minister President Christian Wulff

Dear Professor Carlowitz,

Dear Employees,

As CUTEC celebrates its 20th anniversary, I would like to extend my sincere congratulations to you. On behalf of the government of Lower Saxony, I would like to thank you for what you have accomplished over the years.

Clausthaler Umwelttechnik-Institut GmbH (CUTEC) has become a permanent and dependable fixture in the Lower Saxony research landscape. There are few issues relating to environmental and energy technology which extend beyond the horizon of CUTEC expertise.

CUTEC is involved in a number of exciting research projects that are highly relevant to the current public debate. In the field of environmental and energy technology, the institute is focusing its attention on biomass conversion, fuel cell systems technology and materials and energy resource efficiency.

The emphasis of biomass conversion research is on finding ways of replacing fossil fuels with renewables. Investigations at the pilot scale are underway to develop methods of producing synthetic fuel from a wide variety of biomass feedstock including algae, straw and wood residue, so that we will be able to maintain our level of mobility in the future.

Given the economic trends which we have witnessed over the past 20 years, I have no doubt that CUTEC will continue to be a major contributor and that the institute in its role as an extramural organisation will continue to enhance the reputation of research “made in Lower Saxony”.

Christian Wulff
Minister President of Lower Saxony

THE "ALGAE – AN ALTERNATE SOURCE OF ENERGY AND RAW MATERIALS" WORKSHOP TOOK PLACE ON APRIL 12, 2010 AT CUTEC

A workshop on algae as an alternate source of energy and raw materials was held at CUTEC on April 12, 2010. The event was held on behalf of the Lower Saxony Ministry of Science and Culture. Around 100 individuals from the scientific, business and government communities who attended the workshop demonstrated a high level of interest in this topic. The goal of the workshop was to examine various aspects of the technology and share information on the last developments in algae research and exploitation.

Minister Lutz Stratmann said a few words of welcome at the start of the workshop

In his opening address, Lower Saxony Minister of Science and Culture Lutz Stratmann highlighted the potential use of algae in the food and cosmetics sector. However, what makes algae particularly attractive is its role as a carbon sink. Algae could be used to remove greenhouse gas (CO_2) from industrial emissions. Algae have the added advantage that they do not need arable land to grow and do not compete with traditional agriculture. The list of speakers included Prof. Dieter Sell (DECHEMA e.V.), Prof. Stefan Rill (Phytolutions GmbH), Dr. Wolfgang Frey (Karlsruher Institut für Technologie), Prof. Olaf Kruse (Center for Biotechnology), Stephanie Koch (E.ON Hanse AG), Prof. Otto Pulz (IGV, Institut für Getreideverarbeitung GmbH), Dr. Stefan Vodegel (CUTEC) and Dr. Martin Lohrmann (Volkswagen AG). The speakers shared information on their activities and the

View of the auditorium

results of work done on micro and macro algae. The group discussed issues such as cultivation, conditioning and applications. There was a general consensus on the need for more R&D to expand the molecular biology knowledge base. Additional screening to identify suitable cultures, further reactor system optimisation and improvement of properties for target applications (improved carbon capture) were also highlighted as issues to address. Given the higher growth rates compared to land plants, algae appear to offer significant potential. As algae biotechnology development is an expensive process, high-value products might be the best option for ensuring a good return on investment. Energy applications (biogas plants, fuel) appear to offer attractive opportunities in the long run. In his closing remarks,

The visitors who attended the workshop had the opportunity to learn more about CUTEC during lunch break tours

The speakers and the audience engaged in lively and highly interesting discussions following the talks

Dr. Hans Schroeder from the Lower Saxony Ministry of Science and Culture reiterated the need for multi-disciplinary research. As is the case with fuel cell technology, there is still a long road ahead and a lot of support will be needed. CUTEC's organisation of the event and the workshop itself were given high ratings by those who attended. (gr)

Prof. Otto Carlowitz (right) and Minister Lutz Stratmann at the "Algae – an alternative source of energy and raw materials" workshop

CUTEC – 20 YEARS OF CUTTING-EDGE RESEARCH

After 20 years of highly successful R&D including the last ten years under my stewardship, now is a good time to reflect on what we have accomplished. It is certainly not an exaggeration for me to say that CUTEC has become an established contributor in the Lower Saxony research community. We have invested a lot of effort and will continue our efforts to build up a solid scientific reputation and enhance our image as a highly competent and reliable R&D organisation in the region.

From the business standpoint, the institute has done very well over the years. We now have roughly 100 employees plus around another 50 student research assistants at Clausthal University of Applied Sciences (TU Clausthal). We have also succeeded in attracting 3 - 5 million euros in external financing per year in addition to the basic annual subsidy (currently about 3 million euros) which is allocated to us in the Lower Saxony budget.

Our priority continues to be application-oriented research and development of environmental and energy technology. The focus has naturally shifted over time. Some issues have moved down the priority list, while others have become more prominent as science advances and society evolves. We are positioned between basic academic research and industrial development. We continue to pursue the goal of making the results of basic research work available for applications development and implementation in order to strengthen the economy. Our priority at the moment is research on innovative technologies such as bioconversion, fuel cell system technology and materials & energy resource efficiency. We are addressing these issues on an interdepartmental basis. Because our research activities have always focused on equipment, systems and process technology, we already have the necessary core engineering expertise in biological, chemical, physical and thermal process technology. To supplement the work done by the existing departments at CUTEC (you can read more about these departments and what they do in this issue), we set up biomass conversion and sustainability clusters some time ago to promote transdisciplinary activity and extend our research and strategic horizon beyond departmental boundaries. Plans are in place to set up an energy systems cluster as well.

We can be very proud of what we have accomplished, but we must guard against complacency to ensure future success. As Voltaire once said, "Better is the enemy of good."

I hope that you enjoy reading our anniversary issue, and I look forward to receiving your feedback which you can forward by e-mail to cutec-news@cutec.de.

Yours sincerely,
Otto Carlowitz

The performance and expertise of our team provides a solid foundation for successful research

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20 YEARS OF ENVIRONMENTAL AND ENERGY TECHNOLOGY EXPERTISE

THERMAL PROCESSES

1. The roots

The Thermal Processes Department, which was originally called the Thermal Waste Treatment Department, built on the research activities and equipment of the TU Clausthal Energy Process Engineering and Fuel Technology (IEVB) Institute of TU Clausthal. Under the direction of Prof. Reinhard Scholz, the department acquired partners, projects and equipment for work on pyrolysis, gasification and combustion. The pyrolysis rotary kiln, a forward-acting grate and the MARTIN® reverse-acting grate found their way from the university to CUTEC.

2. Preliminary phase and start up: Prof. Michael Beckmann

Prof. Dr.-Ing. Michael Beckmann

A distinctive pioneering spirit was evident during the startup of CUTEC and Department III (Thermal Waste Treatment). There was now an opportunity to try out ideas that had been formulated into concepts over the years. Pilot units with an average throughput of several hundred kilograms per hour are not exactly a lucrative business opportunity for large engineering firms. The first forward-acting trial gasifier with separate downstream combustion unit (thermal power approx. 0.5 MW) was developed almost entirely in-house with the support of a company which builds small-scale systems. You learn from your mistakes, and at the beginning the learning curve was very steep. The special relationship between IEVB and CUTEC proved to be extremely beneficial. Herbert Hillebrecht, Lutz Trenkner and the entire mechanical and electrical workshop teams deserve special recognition.

Based on the initial results of experimental trials, the researchers continued to refine the process management model and reached the stage where they were ready to apply for research grants which would enable them to carry out detailed investigations, for example primary denoxing techniques and air factor reduction in grate system combustion processes. The next phase involved collaboration with plant operators and engineering & construction firms. The collaborative relationship with the Munich-based company Martin GmbH für Energie- und Umwelttechnik and joint construction of the pilot reverse-acting grate unit (approx. 0.5 MW thermal output) along with the subsequent scientific studies were particularly significant. The researchers concentrated on primary denoxing combined with good combustion, and they then turned their attention to ash quality, mathematical modelling and the behaviour of heavy metals in the furnace.

Pyrolysis rotary kiln – applications: pyrolysis of solid carbon-containing materials to determine process and material parameters

However, the research activities were not limited to gasification and combustion in grate systems. The introduction of the NOELL indirectly heated rotary kiln (throughput approx. 50 kg/h) extended the investigation horizon to include pyrolysis, with material recycling being of particular interest. The range of materials fed into the system included shredder light fraction, plexiglas residue and sludge. A fluidised bed (roughly 75 kW thermal output) was built to study power generation from biomass using finer materials (e.g. sugar beet pulp and olive residue).

Process optimisation based on trials with a variety of fuels in grate, combustion chamber, tubular kiln and fluidised bed reactors provided hard data for assessing the different techniques. The researchers also performed theoretical studies on fuel substitution in collaboration with IEVB.

3. Expansion phase: Dr. Ragnar Warnecke

Dr.-Ing. Ragnar Warnecke

Leveraging its excellent thermal plant infrastructure, the department ramped up its process simulation activities and added additional equipment to enhance its pilot test capabilities. An unpressurised boiler and a flue gas scrubber were added to the MARTIN® grate combustion unit, and significant enhancements were made to the automation and control systems. The department now had the capability to take on flue gas scrubbing projects as well as work related to major problems with waste incineration such as boiler corrosion and contamination. The department carried out a number of projects to evaluate the feasibility of primary air pre-heating, primary denoxing, slag recycling and oxygen enrichment of combustion air, and it also conducted corrosion trials. Dynamic combustion simulation with programmes developed in house improved the understanding of thermal processes and helped define specific solution strategies. Besides conventional instrumentation, the researchers also used specialised equipment such as the new high-temperature endoscope.

Despite the fact that the department concentrates primarily on waste incineration, it has not neglected the issue of material recycling. The technical feasibility of basic chemical recycling, e.g. from PMMA*, at an acceptable quality level was demonstrated on the pyrolysis unit. Combustion, pyrolysis and gasification trials with secondary fuels and biogenic materials such as sugar beet pulp reflect the broad scope of the department's activities. The department's excellent reputation paved the way to discussions with the Lower Saxony Environment Ministry on

MARTIN reverse-acting grate – applications: combustion of solid carbon-containing materials to determine process parameters

placement of thermo-chemical biomass conversion at CUTEC.

A “Stationary Flue Gas Purification” working group was set up in the Thermal Process Technology Department. Under the direction of Prof. Otto Carlowitz, the group took on the challenge of developing functional enhancements to thermal and catalytic flue gas treatment, paying special attention to energy process integration. The department added industrial flue gas cleaning systems to its asset base. Impressive results in denoxing and energy conservation were achieved with the RTO and TNV.

Fluidised bed for gasification – applications: gasification of solid biomass to produce syngas; determination of process and material properties

Four additional research associates have joined the "Stationary Flue Gas Purification" working group. In recent years, innovative solutions for reducing residual contaminants and increasing energy efficiency have been developed, resulting in numerous publications. Highly applications-oriented projects with a very significant level of industry participation were conducted in collaboration with the Chemical Analysis Department. Prof. Carlowitz and various members of the working group are members of commissions which are working on VDI guidelines.

4. Progression from waste incineration to biomass conversion and gas purification: Dr. Stefan Vodegel

Dr.-Ing. Stefan Vodegel

As waste incineration technology matured, the need for research in this field continued to decrease. All of the commercial plants are easily able to comply with strict government guidelines. In close collaboration with the Modelling and Simulation Department, the researchers began to look at innovative grate combustion control systems. Based on a combination of different control technologies and Artificial Neuron Networks (ANN), the team is attempting to look several minutes out into the future, so that corrective action can be taken before an out-of-spec system state occurs. Several years of work will be needed to produce reliable results.

In 2002 under the direction of the Environment Ministry, the State of Lower Saxony approved the construction of a plant for thermal composition of various types of biomass to produce syngas. The specific goal of the BtL (Biomass to Liquid) plant was production of synthetic diesel. Lower Saxony is Germany’s second largest farming state, and the state government wanted to partially restructure the agricultural sector to actively support the energy industry. In recent years, use of synthetic gas has been expanded to include a range of other products to provide raw materials or generate energy (LPG, SNG, electricity and heat). The department has established a close working relationship with the Chemical Process Technology Department at the Biomass Conversion Cluster. A unit for real-world treatment and purification of product gas from the gasification process will soon go into operation to optimise the overall process flow.

5. Future activities

Future activities by the Thermal Process Technology Department will flow naturally from the department’s broad experience base and excellent research infrastructure and from the needs of society at large. Techniques for saving energy during thermal treatment of industrial waste gas will be one priority. The technical feasibility of thermal conversion of biomass has been demonstrated in sustained operation. The future priorities will be efficiency maximisation along the entire chain from the harvest to chemical products and recycling of all by-products. Another very interesting thread will be a “crystal ball” for control systems at incinerator plants. The pyrolysis unit will continue to be available for project work. Given its tradition, mixture of veteran employees and new hires, good asset base and portfolio of advanced activities, the department is well positioned to make an important contribution in the field of thermal processes. (vod)

*PMMA: Polymethylmethacrylat

20 YEARS OF ENVIRONMENTAL AND ENERGY TECHNOLOGY EXPERTISE

CHEMICAL PROCESSES

Fossil fuels play a vital role in our everyday lives. We need oil and gas to heat our homes, and we use petrol and diesel to get from one place to another. 95% of the oil we extract is used to produce fuel and heating oil. Only 5% is used to produce plastics, pharmaceuticals, etc. The Chemical Processes Department at CUTEC has been working intensely on the fuel – drive – emissions process flow for a long time.

The initial emphasis was on reduction of emissions from combustion engines by altering the quality of the fuel and/or emission control technology such as self-regenerating diesel soot particle filters. The diesel engine test bed (Fig. 1) was installed to support this activity, and it was used to develop and refine sampling and analysis techniques.

Besides post-treatment emission control technology, the department looked at improved fuel formulations to reduce emissions inside the engine. Trials were conducted on continuous hydrodesulphurisation of vacuum – gas – oil in a high-pressure hydroprocessing pilot plant. Hydroprocessing of rape seed was also used to produce diesel/petrol substitute which contains no sulphur or aromatic compounds.

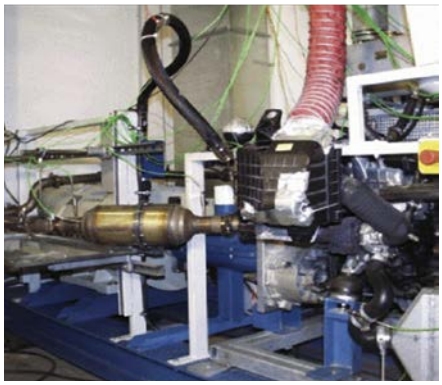

Fig. 1: The department's diesel engine test bed

Researchers gained initial experience with production of fuel from renewables, and the department systematically expanded its knowledge base in the years that followed, in particular following construction of a Fischer-Tropsch pilot unit (Fig. 2). The plant is part of the ArtFuel Test Centre for the production of

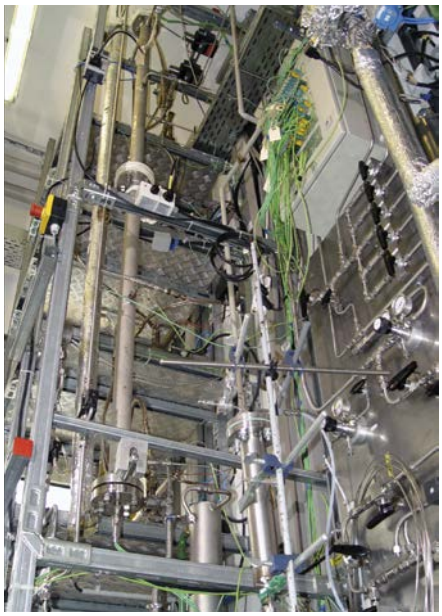

Fig. 2: Pilot Fischer-Tropsch synthesis unit, part of the ArtFuel concept to produce fuel from biomass

synthetic fuel from biomass, which was officially opened on August 5, 2005 by Lower Saxony Environment Minister Heinrich Sander. Based on this highly flexible process, the department worked with the Thermal Process Technology Department to attract R&D project work, particularly from the EU-funded RENEW programme. In 2007, CUTEC was able to demonstrate the world's first pilot-scale production of BtL fuel from straw.

At the beginning of the millennium, development of fuel cell stacks had advanced to the stage where system development created another opportunity at CUTEC to develop highly innovative technology. The first step along this path was the development in 2002 of a gas production system for mobile fuel cell applications. Based on this project, the researchers built up an extensive knowledge base over the next few years and carried out projects (e.g. within the framework of the Lower Saxony Fuel Cell Initiative) which attracted an increasing amount of funding from the Federal Government. Development of a demonstrator for simultaneous production of electrical energy and heat from propane is a good example. This project marked the first time that a high-temperature SOFC fuel cell was introduced and evaluated at CUTEC. The success of this project led to more intensive collaboration with industry in Lower Saxony, providing the basis for a long-term partnership. Support from the firm H.C. Starck deserves special mention.

Dr. Andreas Lindermeir took charge of the Chemical Process Engineering Department on May 1, 2007 following the untimely death of his predecessor Prof. Michael Claußen. The strategic roadmap agreed with CUTEC's Scientific Advisory Board confirmed that the department's priorities are innovative systems technology and component development for SOFC fuel cells and synthesis of renewable fuel and chemical raw materials from biomass.

Fig. 3: SOFC demonstrator to generate electrical energy and heat from propane

At first sight, the two technologies seem to have little in common, but when you take a closer look, you can identify significant synergies (Fig. 4).

The diagram shows the process steps on three current research projects. Work is in progress on efficient generation of electricity from biogas using a high-temperature fuel cell. The process includes secondary biogas purification and a reformer to generate the fuel gas. Similar subsystems were developed for synthesis applications, e.g. distributed production of high-grade Fischer-Tropsch wax from biogas or natural gas.

There are two other projects of major strategic importance. In 2009, Lower

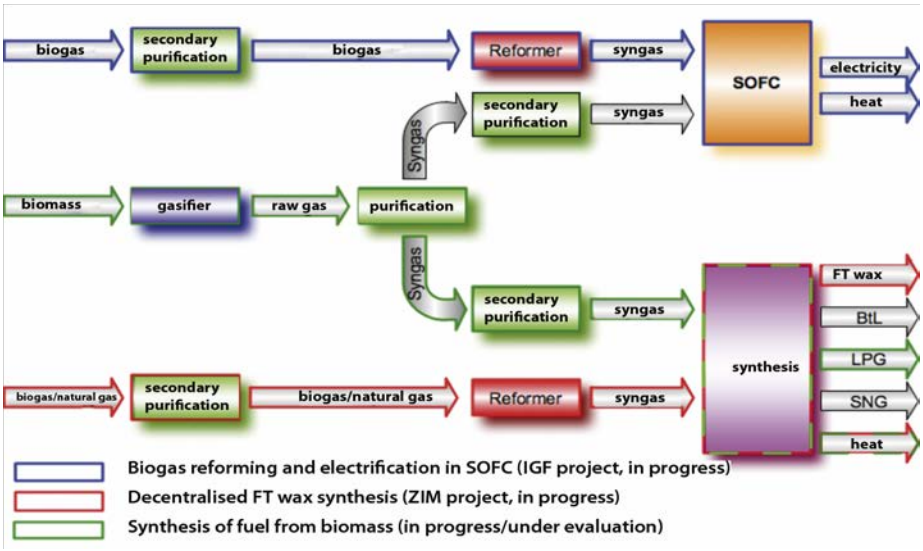

Fig.4: Examples showing how networking supports the major development activities in the department

Saxony approved funding for construction of a pilot Fischer-Tropsch synthesis plant. The entire existing knowledge base will be used to move the technology closer to real-world application and industrial implementation. The engineering work is now complete, and construction of the various

Fig. 5: Installation of the first pilot Fischer-Tropsch unit by the workshop team

process stages is currently underway (Fig. 5). The plant will have two six-meter synthesis reactors running in parallel which can operate at different pressures and temperatures to provide maximum flexibility. Design and implementation will reflect standard industrial practice, particularly heat management and instrumentation & control. The pilot plant will act as a model for scale-up at a later date and construction of a demonstration plant. The project is being executed in close cooperation with the Thermal Processes Department to develop technology for future production of BtL fuel from biomass in volumes of a few kg/h. This will provide enough fuel for trials on the engine test beds.

The department also acquired an SOFC fuel cell project which has major strategic implications. The Lower Saxony Research Alliance was formed on March 1, 2010 with seven institutes at the Universities of Hannover, Braunschweig, Clausthal and Osnabrück along with high-profile industrial partners (BMA AG, EWE AG, H.C. Starck GmbH, Sieb & Meyer AG, GEA Ecoflex, Solvis GmbH and others) for the development of a compact, high-efficiency 300W SOFC system. This marks the first time that all of the institutes and companies in Lower Saxony which are working of high-temperature fuel cells will join forces over a period of three-years to drive fuel cell technology closer to market introduction.

Eight employees currently work in the Chemical Processes Department (6 scientists and 2 technicians, Fig. 6). CUTEC Central Services along with student assistants and students who are working on research papers or writing their theses provide additional support as needed. Over the past three years, the department acquired more than €2.5 million in external funding, contributed more than 15 talks and posters at international conferences, and published articles in peer-reviewed journals. (li)

Fig. 6: Chemical Process Technology team

20 YEARS OF ENVIRONMENTAL AND ENERGY TECHNOLOGY EXPERTISE

BIOLOGICAL AND PHYSICAL PROCESSES

A brief look back

It all began with industrial effluent treatment and the development of a pilot container unit for treatment of complex waster water at the TU Clausthal Thermal Engineering Institute. Because mechanical and biological treatment alone do not provide the desired purity levels with complex effluent, chemical oxidation and adsorption techniques are also needed. Early experience with a variety of methods and combinations of methods in the mid 1990s pointed in the direction of an expanded and increasingly holistic system approach to wastewater treatment. By-products were part of the equation, in other words sewage sludge treatment including sludge conditioning, dewatering and digestion. Process water recycling became another priority, because techniques for treating complex wastewater are also suitable for ensuring compliance with drinking water quality standards. Dynamic simulation of wastewater treatment systems was developed as researchers gained a better understanding of the process.

The experience gained with sludge digestion provided the basis later on for studies of biogas production from renewables. Work has intensified in this area, as the institute contributes to the development of a sustainable energy supply.

Results

As is often the case in the world of research, a number of patents (more than 10) were granted to the department, and a significant number of works were published (more than 100). It is important to keep in mind however that many of the results have not been published because of non-disclosure agreements. Many research papers and theses (around 60) including several doctoral theses (about 10) were completed, partly because founding Managing Director Prof. Leschonski specialised in physical process technology, and Prof. Vogelpohl kindly took over principle reporting responsibility during the startup phase.

There were also noteworthy activities in the international sphere. CUTEC instituted a popular international series of conferences on water and wastewater oxidation treatment methodologies along with the associated PR activities, and it acted as coordinator on a number of EU projects.

Projects from the European Commission, the German Environment Foundation (DBU), the German Federation of Industrial Research Associations (AiF), the German Ministry of Economics (funding channelled through AiF Berlin), the German Ministry of Research (project managed by Jülich), the State of Lower Saxony, N-Bank and the Agency for Renewable Resources (FNR) provided funding for excellent laboratory and test centre facilities. The department has the capability to test a wide variety of processes, from bench, test centre and pilot scale right up to industrial scale in some cases. With wastewater treatment techniques needing to be assessed on site because the composition of the water can vary greatly in real-world conditions, container-based test facilities were developed to conduct field testing.

Highlights

There were a number of success stories where the department was able to move from laboratory scale to practical implementation.

Landfill leachate treatment. Leachate treatment is nothing new, and many solutions have already been developed. However, new approaches can achieve significant savings. Work in this area began with the construction and trial of a test plant in the Osterode am Harz district and resulted in an innovative and cost-effective leachate treatment technique (Fig. 1). Non-biodegradable substances are screened out following precipitation/flocculation. The success of the screening process depended on new flocculation equipment which increases floc shear stability. This equipment was developed and produced in house for the treatment plant. The experience that the department gained during the development, design, construction and optimisation phases has helped researchers to

Fig. 2: Sludge conditioning pilot plant (throughput 40 m³/h max.)

better understand the cost structure of future process development work, and that knowledge will help them on subsequent projects with industrial partners.

Sludge dewatering. Dewatering of sludge has also been around for a long time, but there appears to be significant need for optimisation in the future. Compared to the amount of effort expended on machinery improvement, comparatively little effort has been put into research on the upstream conditioning process (flocculation process technology). Based on encouraging lab results at CUTEC, a flocculation process along with suitable equipment was developed starting at laboratory scale and continuing right through to industrial implementation (Fig. 2). Special thanks are due to the German Environment Foundation (DBU) for partially funding the development work. The process improves dewatering performance and reduces polymer consumption. The centrate/filtrate has lower solids content, providing greater leeway during operation of dewatering machinery. Plants using this technology have already been built in Germany and Japan.

Sludge digestion. Sludge digestion can meet part of the energy needs at sewage treatment plants. Process intensification can increase the proportion of energy generated in house. A mechanical homogenisation process (Fig. 3) developed within the framework of an international partnership achieved a digestion level of 60% with dry organic material during engineering testing. The process produced about three times more electricity than was needed to run the process.

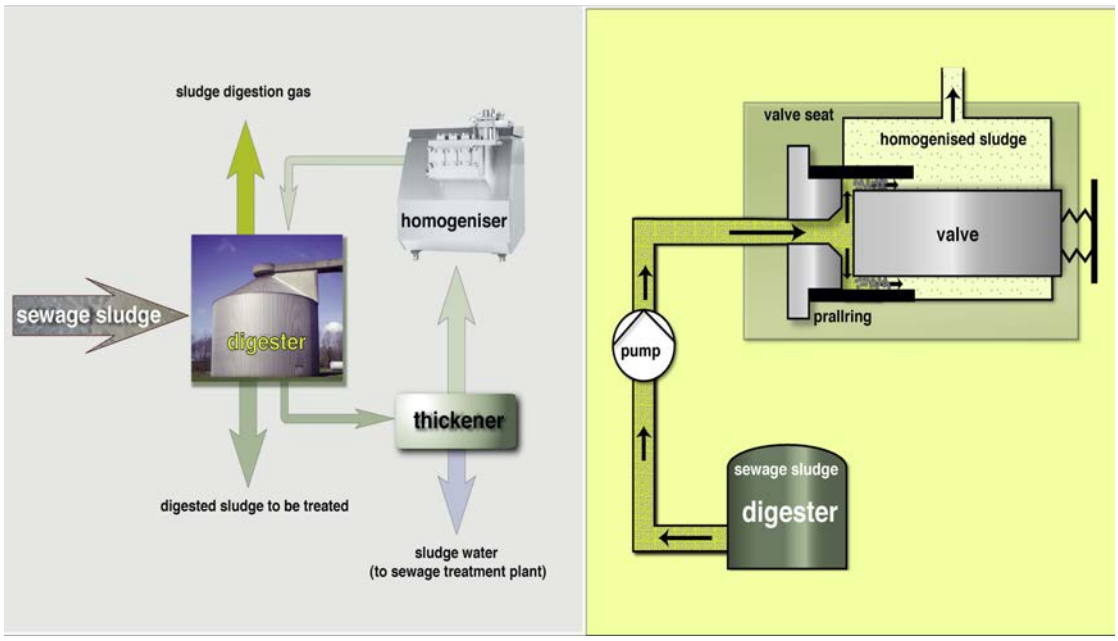

Fig. 3: Princple of operation – intensification of the digestion process

Bild 4: Pilot harbour sludge conditioning plant

Flocculants derived from renewable resources. On a project funded by the Agency for Renewable Resources (FNR), CUTEC joined forces with an industrial partner, a user and the University of Hamburg Institute for Technical and Macromolecular Chemistry to study new starch-based flocculants and their applications.

Using harbour sludge dewatering as an example, the researchers analysed the conditioning process and identified the need to optimise the chemical modification of the starch. The joint project led to the development of a starch-based flocculant which is competitive both from the cost and the engineering point of view. The fact that the results are relevant to sewage sludge dewatering adds an increased level of significance to the results. In view of the fact that from 2013 the spreading of polymer flocculated sludge on agricultural land will be prohibited, this process can provide a cost-effective alternative

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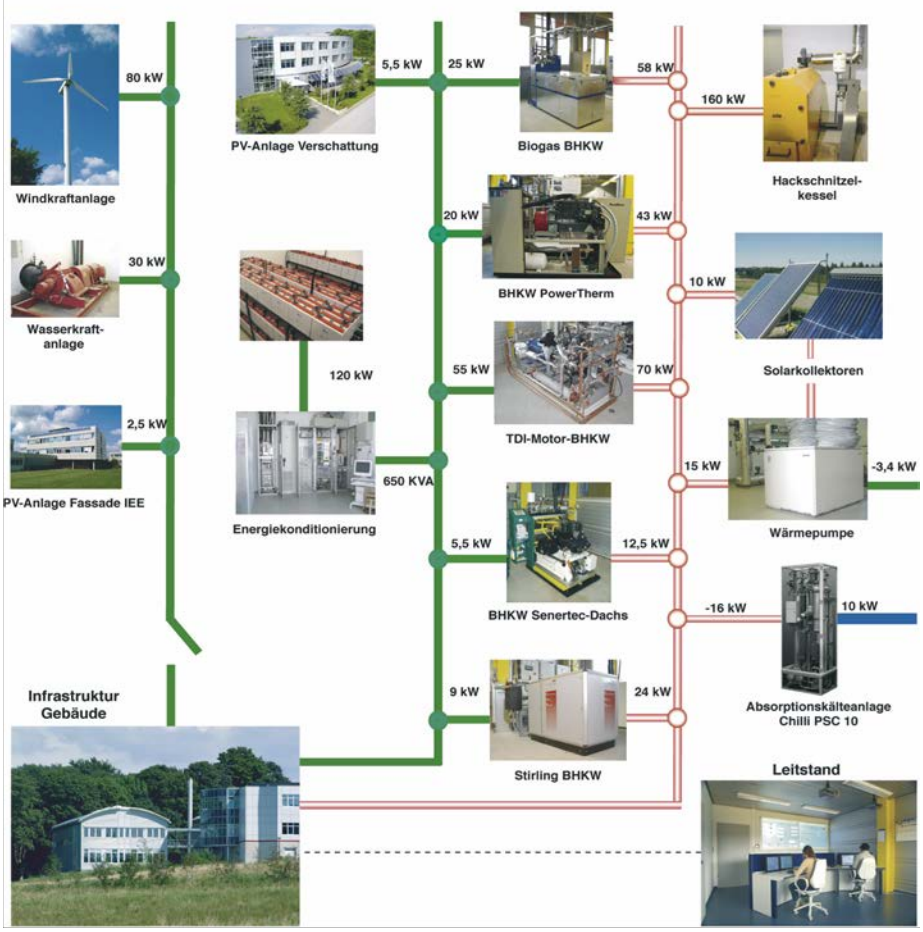
20 YEARS OF ENVIRONMENTAL AND ENERGY TECHNOLOGY EXPERTISE

10 YEAR ANNIVERSARY OF CLAUSTHAL ENERGY PARK

Clausthal Energy Park is celebrating its 10th anniversary this year. The originally planned duration of this project has actually now elapsed. However, back to the beginning. Rumour has it that 2 professors (Prof. Beck and Prof. Jeschar as some of you might have guessed) from TU Clausthal discussed the idea of an energy park over lunch in the cafeteria one day. But the question was where to put it and who should be involved. At that time, CUTEC was in the process of moving into the new building and the first pilot units were being installed. What could be more logical than to supply renewable energy for the impressive new building? The fact that CUTEC had its own state-of-the-art supply and disposal infrastructure, placing it at an advantage compared to any institute building at the university, made the decision even easier. The next step was to discuss the idea with Prof. Leschonski, Dr. Beckmann and Mr. Siemers at CUTEC. That was back in September 1996. Once the outline of the project had been drawn up, contact was made with the German Federal Environmental Foundation (DBU). The first draft of the funding application including the basic definitions and concepts was ready at the end of 1997. The proposal contained a plan to meet all of CUTEC's electricity and heating needs using a combination of different renewable energy sources to provide a high level of supply service quality. The innovative idea of combining a number of different power generation units to create an overall energy supply system plus the availability of the system for demonstration and research/teaching purposes were the most attractive aspects of the project. A total of DM 4.5 million was allocated for the wind power plant, hydropower plant, PV installation, anaerobic digester, biomass use, vegetable oil use, heat pump and control station along with the associated and necessary infrastructure. The original application included expansion of the Energy Park with CO2 recycling using micro algae, deployment of fuel cells and the use of absorption chillers to recover waste heat.

Another two years elapsed before DBU approved the Clausthal Energy Park at the decisive meeting of the Board of Trustees. Changes had been made to the proposal,



Coupling of individual components of the energy park and installed capacities

answers were provided to questions which were raised and the details were discussed with DBU before the final decision was made. The project was approved on October 25, 1999 with an overall budget of DM 3,564,000 including DM 1,782,000 provided by DBU as grant. The reduction in funding had to be discussed with the partners, and agreed upon between the partners. Final agreement was reached at the beginning of 2000 in the form of a cooperation contract between CUTEC and TU Clausthal. The project officially got underway on April 1st, 2000, which was unfortunately too late for anything of substance to be ready in EXPO year 2000.

So much for the preliminaries and historical framework. What actually is the Energy Park project? The full version of the project designation is "Clausthal demonstration plant for decentralised renewable energy systems". This describes a system oriented energy supply with the main feature of being decentralised and all energy requirements are met by renewable energy resources. The plant is used for demonstration purposes and as a research and teaching resource. The Energy Park is designed to supply all of the energy needs of the CUTEC building without any impact on the demand profile. To show that 100% renewable supply is possible, the site can run in off-grid conditions, which demonstrates the extreme case of decentralised autonomus energy supply. A number of different energy conversion technologies with different characteristics are combined to generate electricity. Output from wind power, hydroelectric power and PV generators cannot be controlled or regulated, but the output is predictable to some extent depending on weather and climatic conditions and the time of day or season of the year. To guarantee a certain (albeit fluctuating) level of supply, switchable energy generation was needed which can be regu-

Clausthal Energy Park building – Clausthal demonstration plant for decentralised renewable energy systems

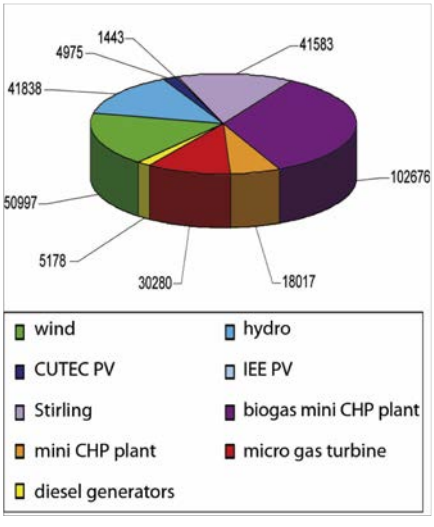
lated and which can store energy. The solutions include biomass (solid, liquid and gas) used in small power stations or CHP stations and batteries, which can act as a chemical storage medium. Heat is supplied by solar radiation, biomass and ambient heat. Over time, each of these energy conversion systems was designed, built and commissioned at CUTEC and connected to the overall system. DBU funding was initially granted for a period of three years, and the agreed project duration was 10 years.

The illustration at the top left shows the current status. A local utility company supplies energy generated with existing wind and hydropower systems. Two PV systems are also installed. The Institute of Power Engineering (IEE) and the Institute of Energy Process Engineering and Fuel Technology (IVEB) at TU Clausthal continue to provide services within the framework of the partnership. Battery storage and a large inverter are used for energy conditioning (necessary in autonomous mode). Fortunately, a new pilot plant building was being constructed for CUTEC at around the same time, so space became available for the control station, engine room and distribution equipment. A number of small power generation units are installed in the engine room to supply electricity and heat. The installed technology base is exceptionally broad. A range of different CHP plants were deployed in collaboration with other projects (4-cylinder CHP, mini CHP, single-cylinder CHP, two Stirling engines and a micro gas turbine), and an absorption chiller was added as well (FEN project). The list also includes a wood chip boiler, solar collectors and a heat pump.

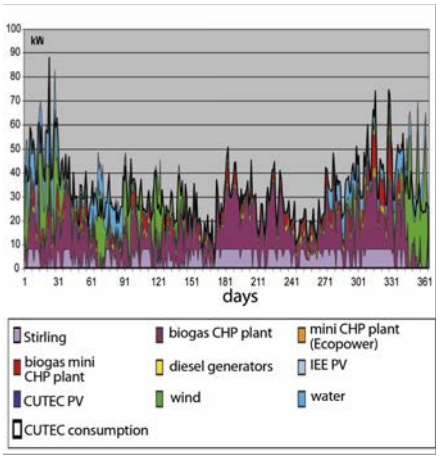
The results show that 100% of the energy needs can be met from renewable sources when all available types of energy are used. The entire operation is exceptionally dynamic, as can be seen from the 2003 summary.

What did it all cost? The total cost exceeded the funding available in the planned budget. A final statement was made for 2.25 million euros. The average cost of electricity generation could be calculated to 27 ct/kWh. However, the extras (energy conditioning and the control station) add another 22 ct/kWh. Heat was supplied at nearly the break-even point.

What has been the impact of the Energy Park? Over the course of the project, more than 20 research and projects papers and degree theses have been written on a broad range of topics at the Energy Park. Hundreds of visitors from a whole range of backgrounds (from housewives to the Prime Minister) have come to see the installations. The Energy Park has also featured in a series of articles and reports in scientific journals and Internet forums. The project has certainly had the desired effect as a demonstration site, for general information purposes and as teaching support tool. Based on the installed capacities and the experience gained, the Park has attracted additional third-party funding for CUTEC and TU Clausthal.



Covering CUTEC electricity needs 2009 (kWH)



Covering CUTEC electricity needs throughout 2003

Overall, it has been well worth the investment despite the fact the partners had to invest a lot of effort and resources in the Park. The 10th anniversary of the park is a genuine occasion for celebration. (sie)

Collaboration with TU Clausthal

The Clausthal Energy Park project was launched to demonstrate and investigate ways of generating the energy needed at a building complex from wind, hydro, photovoltaic, solar thermal and biogenic energy sources. The project provides an opportunity to move from theoretical modelling and conceptual development to practical application, and it is a major challenge to everyone involved. Two institutes at TU Clausthal, the Electrical Power Engineering Institute (IEE) and the Energy Process Engineering and Fuel Technology Institute (IEVB) along with a local utility (Stadtwerke Clausthal-Zellerfeld GmbH) have joined forces with CUTEC in the partnership. The partners use their power engineering and energy process technology expertise to achieve the project goal of supplying electrical and thermal energy

Continued on page 23

20 YEARS OF ENVIRONMENTAL AND ENERGY TECHNOLOGY EXPERTISE

CHEMICAL ANALYSIS

Chemical analysis has been going on at CUTEC ever since the institute was founded 20 years ago. The name has changed from Physical, Chemical and Biological Environmental Lab to Chemical Analysis, but that is not the only change. The task spectrum for this small group which has worked under the direction of Dr. Andreas Meyer (until 1998), Dr. Klaus Schrickel (until 2004) and Dr. Axel Fischer (since 2004) has also continued to evolve. At the halfway point of the first ten years, the move to the new building was a major step forward for the Chemical Analysis team which was able to add new equipment in the more spacious facilities.

Initially, the group concentrated on environmental analysis and analysis of samples taken from waste treatment processes. The study of corrosion processes was added to the task list over time. To support this activity, a test bed which is probably the only one of its kind was installed to test the stability of materials when exposed to realistically simulated atmospheres. Liquids can also destroy metallic materials. The service life of seawater plate heat exchangers principally depends on the selection of suitable metals during the design phase. To help make the right decision, the Chemical Analysis Department has a seawater test bed to imitate real-world operating conditions and to accelerate the corrosion process during trials.

Fine adjustment of the heated sampling probe

The entire department at the workplace

So it's better to rust than rest? Yes, but there is more to it than that. CUTEC began looking at a totally different set of reaction products and processes. Biomass conversion research at the cluster presents a wealth of challenges to the analysis team including tricky and laborious extraction of samples from gasification and pyrolysis processes. The department also supports projects designed to increase resource efficiency by studying the composition of plant stalks and other feedstock. Quality analysis of process and biogas is also part of the task spectrum.

This brings us to a group which has been part of the Chemical Analysis Department since 2006 and which primarily concentrates on compliance with § 26 of the German Clean Air Act. Under the direction of Dr. S. Weineck, the team conducts mobile ongoing assessments of gaseous emissions. High-profile car manufacturers and utilities are part of the core customer base. High on the list of analytes are ammonia, nitrogen oxides, carbon monoxide, organic chemical compounds such as BTEX aromatics* and polycyclic aromatic hydrocarbons (PAH) which are found in cigarette smoke and grilled meat. Besides providing data on compliance with regulatory requirements, the results support process optimisation efforts undertaken in collaboration with other departments at the institute. These synergy effects are a good example of close interdisciplinary cooperation at CUTEC.

Preparing to take tar samples

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*BTEX-Aromaten: Benzol, Toluol, Ethylbenzol, Xylole

20 YEARS OF ENVIRONMENTAL AND ENERGY TECHNOLOGY EXPERTISE

MODELLING AND SIMULATION

Initial prototype of the DETECTINO utility line locator system

Under the direction of Prof. Matthias Reuter, the Modelling and Simulation Department at CUTEC developed "implicit modelling", which is an entirely new approach to modelling and simulation, to the point where it was ready for implementation.

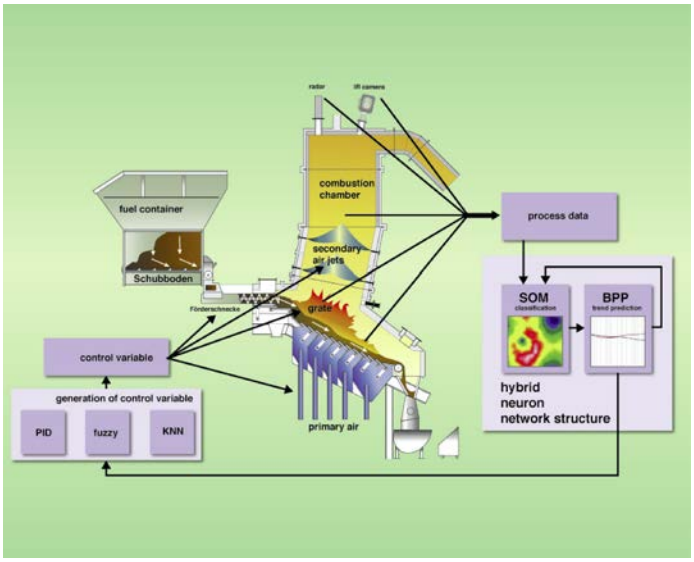
Essentially, implicit models are generated from an acquired data set with the aid of self-organising systems like neural networks. The models can then be used for control, detection, classification, identification, data mining and design of command and control systems. This approach has the enormous advantage that the process does not have to be described in explicit mathematical terms to perform the tasks listed above, and the problem of dealing with volatile process conditions can often be resolved.

The Modelling and Simulation Department has used this approach for the following tasks in recent years:

➢ Mission-specific design and implementation of neural-based predictive control systems for process control and robotic systems.
Data-based implicit models are used for situation-specific process or machine control. Due to the specific nature of the modelling architecture, these predictive, adaptive systems have the learning capability to react to aging and task-related changes or general system changes.

➢ Neural-based classifiers/identifiers for military and civil applications.
Due to their structural problem adaptability and high level of immunity to disruption, soft computing based algorithms are suitable for the following applications:

- acoustic pattern recognition/object identification/scene analysis
- optical pattern recognition/object identification/object evaluation/scene analysis
- general information detection and information space analysis
- scene analysis of electromagnetic signals



Basic design of a CI-based predictor for waste incineration plants

➢ Statistical/CI-based data mining methodologies for time sequence analysis of process/state variables to define non-redundant key process metrics.
Data mining methodologies are used to structure data sets of any length. Redundant information is eliminated and key system-descriptive process parameters are defined, providing the basis for creation a meaningful description which has relevance for ongoing process control. Large applications using these new methodologies have already been developed for the financial and management world.

➢ Generation of database-supported dynamic command and control systems.

Information with varying content and format is integrated dynamically and in near real time into a general information space, where it is analysed and structured as needed to perform temporary tasks. The data is presented in situation-relevant visualisations.

The efficiency of the new approach and technical implementations has been demonstrated in numerous applications including the following two examples. In 2007, the defence industry's innovation prize was awarded for a method of detecting metal objects in the ground. In 2010, a special technique for scene analysis of electromagnetic signals was nominated for the bauma innovation prize and as a landmark in the "Land der Ideen" competition.

Current R&D activity is focused on the development of CI-based detection and identification of buried utility lines and the development of CI-based predictors for state variables at waste incineration plants. (reu)

20 YEARS OF ENVIRONMENTAL AND ENERGY TECHNOLOGY EXPERTISE

BIOMASS CONVERSION CLUSTER

From biomass to synthetic products

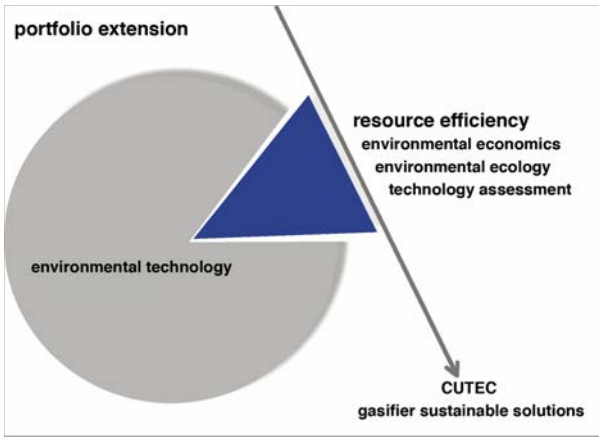
The large European RENEW programme which got underway at the beginning of 2004 was a collaborative effort. 33 partners spearheaded by Volkswagen joined forces to come up with ways of producing 2nd generation fuels from biomass. The Chemical and Thermal Process Engineering Departments at CUTEC were involved in the programme. The Biomass Conversion Cluster was formed in 2005 to provide a suitable organisational umbrella. The cluster served as a framework for information updates, work scheduling and responsibility allocation. RENEW ended in 2007, but the cluster remains in place, and all thermal biomass conversion and synthesis projects are now within its area of responsibility. Excellent teamwork facilitates the execution of difficult projects such as the recent construction of a pilot-scale Fischer-Tropsch synthesis unit. A. Wollmann (CP Dept.) is leading the effort to convert all of the syngas into 2nd generation fuel on the new purification line managed by F. Müller (TP Dept.) which is currently in the startup phase. The scientific and engineering teams from the two departments are working hand in hand on the project. Once the systems are in place, the cluster will have everything it needs to begin experimental production of BtL, LPG and wax on a pilot scale using biomass such bales, husks, wood chips, etc. as feedstock. The infrastructure is now in place in Clausthal which enables CUTEC to conduct high-level scientific research to increase overall efficiency, convert by-products into useable products, etc. in a continuing effort to meet the future needs of society. The cluster will provide an organisational framework for years to come. (vod)

SUSTAINABILITY MANAGEMENT CLUSTER

The Sustainability Management Cluster (CNM) is a relatively recent addition to the CUTEC organisational structure. This entity which crosses departmental boundaries evolved as part of the company development process.

The following scenario and considerations led to the formation of CNM:

- Sustainability management was a major evaluation criterion (2005); it was highlighted as a potential unique selling point
- CNM provides the opportunity to deliberately build a sustainability knowledge base as a major strategic asset
- CNM can support a holistic in-house strategy
- The issue of sustainability is placed in a defined context and becomes measurable
- CNM augments the operational departments
- CNM can generate additive references



Grapic representation of the extension to the CUTEC portfolio

The illustration above shows the synergetic extension of the CUTEC portfolio to develop sustainable environmental technology solutions.

In 2008, CUTEC's Scientific Advisory Board approved the establishment and strategic orientation of the Sustainability Management Cluster along with the following deliverables:

- market research and marketing activities
- economic and ecological instruments and assessments
- risk/opportunity analysis
- soil conservation: attributes, contaminants, clean-up
- geopotential utilisation
- sustainable material cycles, resource efficiency
- organisation and staging of national/international events

Continued on page 24

INITIATIVE OF LOWER SAXONY FOR FUEL CELL AND BATTERY TECHNOLOGY

SCIENTIFIC COMPETENCE CLUSTER AT CUTEC

The N.ERGHY Executive Board following the election in April 2010:
Luis Correas, Hidrógeno en Aragón, Spain / Vincenzo Antonucci, CNR - National Research Council, Italy / Paul Lucchese, CEA, France / Christian Sattler, DLR, Germany / Angelo Moreno, ENEA, Italy / Steffen Møller-Holst, SINTEF, Norge / Frank de Bruijn, ECN - Energy research Centre of the Netherlands / Rolf Rosenberg, VTT - Technical Research Center of Finland / Ralph-Uwe Dietrich, CUTEC, Germany und Jörg Nellen (3.v.r.), DLR, N.ERGHY Secretariat & Brussels office

The office for one of three Competence Clusters in the Lower Saxony Fuel Cell Initiative has been located at CUTEC since 2004. An article appeared in the December 2004 issue of CUTEC News. It has been our intention to contribute to the success of the initiative and to concentrate on the following:

- initiate networking to pool the fuel cell expertise of research institutions in Lower Saxony
- identify existing potential in the local economy in order to foster cooperation between the scientific and business communities
- take up the challenge of SOFC technology in particular to enhance the economic performance of this technology in Lower Saxony
- pool research capacity, particularly at the Clausthal-Zellerfeld site, and enter into close partnerships industrial companies in the region
- review state, national and European research programmes in order to develop and submit as many successful project proposals as possible.

In the meantime, the Competence Cluster Science for the Lower Saxony Fuel Cell and Battery Technology Initiative has developed into an active platform for the state's scientific community to share information on issues related to the state's research policy and on the challenges involved in ongoing development of fuel cell technology. All of the scientists who are working on fuel cell technology in Lower Saxony contribute to the information sharing process. A summary of their activities and main areas of interest is available online (in German) at www.brennstoffzelle-nds.de

A number of research projects have been initiated, approved and carried out in collaboration with local industry. Projects of this type help familiarise the companies with fuel cell technology and facilitate the establishment of partnership networks.

SOFC is now one of three thematic focal points at CUTEC. The total funding in completed and ongoing research projects has already passed the €7 million mark. The most recent example is the establishment of a Lower Saxony research alliance to develop an autonomous, small power propane-based SOFC fuel cell system featuring a high degree of thermal integration. See Page 22 of this CUTEC-News for more details.

The Competence Cluster Harz is also active at the European level. CUTEC has been representing the Lower Saxony scientific community at N.ERGHY, the European hydrogen and fuel cell research association. At the last general meeting, Mr. Dietrich was elected to the association's Executive Board where he has responsibility for the Early Markets working group. Board members are shown in the photo following the election.

(di)

Continuation from page 12

CHEMICAL ANALYSIS

The first chemical lab technician trainee was also expected to take an interdisciplinary approach. Mrs. Isabella Legzdins was comfortably able to handle this challenge and others, and she achieved good results in her final examinations in January. As is often the case, the newly qualified chemical lab technician immediately found employment at the end of her training course. The Chemical Analysis Department wishes Isabella all the best in her future career.

(fi)

emission measurement

20 YEARS OF ENVIRONMENTAL AND ENERGY TECHNOLOGY EXPERTISE

SERVICE PROVIDERS AT THE INSTITUTE

Business services and administration

The role of business administration at CUTEC is active rather than passive. The team ensures that sufficient financial resources are available for the operational activities and takes a holistic approach to the economic and financial flows at CUTEC. The range of responsibilities includes financial administration, human resources, internal services, material acquisition and management and library services.

The bookkeeping team and the budget accounting systems track all of the financial flows including flows initiated by the operating departments. Further analysis for reporting and costing purposes is derived from this data.

The CUTEC Human Resources function ensures the confidentiality of personnel information, manages the payroll and processes HR data for third parties as appropriate.

Procurement activities were centralised at CUTEC a few years ago. The primary advantages are cost-effective procurement and workload reduction for operational staff. Data from procurement activities can be extracted for use by the material management and accounting teams, producing an additional synergy effect.

Our team is also responsible for central administration and looks after the buildings and central facilities and equipment. (so)

A highly-qualified team takes care of administrative affairs at CUTEC

Workshop facilities / building services / design services

An experienced and highly skilled team carries out sophisticated work in the institute's workshops

Besides business administration, Central Services at CUTEC also provides technical support to the operating departments during execution of research projects.

In addition to its normal functions, building services is also responsible for health & safety, fire prevention and environmental protection. It is also heavily involved in modifications to the buildings and in construction work.

Before items of equipment can be produced, designs issues have to be addressed and other work has to be carried out in close coordination with the operating departments to ensure that the defined requirements can be incorporated into the drawings. The department creates and manages the necessary documentation.

The mechanical workshop has the equipment, tools and machinery needed to support research projects along with the expertise to meet project requirements.

CUTEC has the metalworking capabilities to produce complex frames, special items and device prototypes. In many cases, electrical circuitry has to be installed in the equipment. CUTEC has an electrical workshop which is equipped to provide what the operating departments need. (so)

IT systems, graphics and media technology

Our department, which has a long name, is part of Central Services. We are an internal service provider for the line departments. The activities at every workstation in the department are centred on computers. Our portfolio extends from IT services and design / production of all types of media to the organisation and staging of trade shows and events. Our main IT activities consist of user support and maintenance / upgrading of IT systems which provide essential services such as e-mail and Internet access.

A graphics workstation is available for creative work such as the design of logos and flyers and the generation of presentations, brochures and advertising material. Document, image and graphics editing is part of the everyday routine.

Our media technology team documents the construction or modification of test systems on film or video. They also perform video editing and provide media support at all events in house or on site. In addition, the department is involved in a limited amount of PR work such as publication of CUTEC News, design of the website and organisation of CUTEC appearances at shows at home and abroad. We look forward to seeing you at our IFAT 2010 stand in Munich in September. (he)

The IT administrators during an installation in the machine room

THERE IS ANOTHER WAY: DEZINCING STEEL SCRAP II

The Sustainability Management Cluster (CNM) has acquired the research project "Dezincing of scrap steel" from the German government (BMBF). The agency responsible for the measure is Jülich/Berlin, which will act as the point of contact for administrative coordination during the 3-year project. The following are partners in the joint research project: Prof. Gock and his team (IFAD/TU Clausthal), Sundwig GmbH (Andritz), RHM, Xstrata, Fritz Winter, Wolfsburg AG and ProGENF. Mr. Sauter (CNM) is the project manager.

A report on the conceptual design and plans for construction of the dezincing unit appeared in the June 2009 issue of CUTEC News. At the beginning of 2010 the experimental unit was then installed in the north building at CUTEC. The premisses for the unit were drawn up on the basis of laboratory-scale and preliminary reaction kinetics experiments. Numerous meetings involving IFAD, ProGENF, Sundwig GmbH (the company with responsibility for constructing the unit) and CUTEC had been held to keep the planning process moving. A special challenge in this connection was the need to adapt industrial equipment to the requirements of a pilot unit for R&D purposes. Providing maximum flexibility to integrate different process stages, such as electrolysis for future detinning stages, was a top priority. This requirement was met by using interconnected, identical individual modules arranged in series rather than a conventional tank section. Other requirements included a slow, adjustable feed speed for the conveyors, mechanical resistance to the sheet metal transport, and very easy repairability combined with robust continuous operation. On top of these special requirements, the equipment has to withstand an acidic pH value as low as pH 2.5. This requirement was derived from the reaction kinetics based on the use of locked-out cell acid. The illustration below shows the flow chart for the acid dezincing process in overview form.

Cell acid locked out from the zinc works with low zinc content (20% sulphuric acid) is fed into the dezincing unit to strip the zinc from galvanised sheet metal scrap. When the acid has reached its zinc loading limit, it is returned to the zinc works and the zinc is recovered using an electrolytic process. Reuse of the electrolytically purified acid in the pilot dezincing unit closes the zinc recycling loop. This process represents an enormous improvement compared to the state-of-the-art method. Large volumes of lime and coal are needed for the current zinc recovery process (Waelz method), and large amounts of energy are required to volatise the zinc in an electric arc furnace and to run the Waelz process. The new innovative method could presumably save enormous amounts of material and energy resources compared to the conventional approach.

In addition to the savings achieved by the innovative zinc recovery technology, it produces dezinced sheet metal scrap for which there is great demand in high-tech applications such as the casting of wind turbine hubs and the prevention of contaminants in high-temperature circuits.

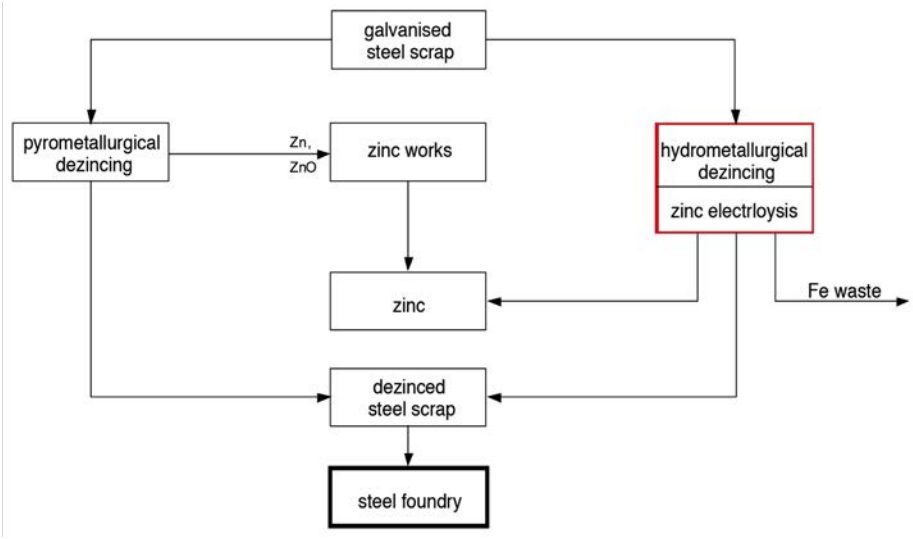


Fig.1: Acid dezincing process flow chart

Fig. 2: Installation of the acid-proof enclosure

The construction of the pilot unit began in December 2009. Because sulphuric acid is used, the unit had to be embedded into an acid-proof trough.
Fig. 2 shows installation of the acid-proof enclosure just getting underway.

The steel structure was installed next, and the individual modules were then mounted onto it (Fig. 3).

Fig. 3: Design of the steel structure

Continued on page 24

SCIENTIFIC ADVISORY BOARD

A PROFILE OF PROF. VOLKER WESLING

Prof. Dr.-Ing.
Volker Wesling

In this anniversary issue of CUTEC News, we would like to tell you a bit more about Prof. Wesling who was elected as Chairman of the Board in December, taking over from Prof. Beck.

Volker Wesling was born in Hildesheim in 1962. After completing vocational training as a precision mechanic at Blaupunkt, he was enrolled in a mechanical engineering course at TU Clausthal from 1984 – 1989. He subsequently worked as a research assistant at the Welding and Machining Institute at the university. In 1993, he received his doctorate from the Mining, Metallurgy and Mechanical Engineering Department. He then worked for nine years in the machinery manufacturing industry, spending some of that time at Mannesmann. He held a number of production and manufacturing management positions including Managing Director. Volker then moved to TU Clausthal as Professor of Welding and Machining, and since then he has been the head of the ISAF institute. He specialises in low-heat joining and welding processes, production milling operations and material-based production technology for fuel cells. Prof. Wesling has been a DFG consultant since 2002. He was a member of the SFB 362 special research centre (sheet metal processing). He has also been a member of SFB 675 (Creation of high strength metallic structures and joints by setting up scaled local material properties) ever since it was founded in 2005. In addition, he has been in the Academic Senate since 2005. From 2005 – 2008 he was Deputy Dean of Studies for Mechanical and Process Technology in the Mathematics/IT and Mechanical Engineering Department, and he acted as Vice-Dean from April 2008 until his appointment as Vice-President of Research and Technology Transfer in October 2009. Prof. Wesling has been on the Executive Board of the Clausthal Material Technology Centre since 2007. He is also on the Executive Board at the Joining Technology Association, and in the same year he became an Honorary Professor at Kirgiz Technical University. Prof. Wesling joined the Executive Board at Hanover Laser Centre in November 2009.

When asked about what motivates him, Prof. Wesling made the following observation: "What I am trying to do is encourage collaboration between TUC and CUTEC to promote research on eco-friendly production techniques in Clausthal. The goal is to increase the competitiveness of SMEs in the manufacturing industry." (he)

Continuation from page 9

for the countryside, and our engineering and scientific investigation will continue.

Biogas. Recognising the biogas potential of substrates and substrate mixtures plays a significant role in the optimisation of biogas plants. Techniques include the standardised anaerobic digestion test which is defined in VDI 4630. Despite standardisation, test results from the same trial can vary by more than 10% and as much as 20% in some cases. As a workaround, the mean value is normally calculated from three sets of test results. A solution was clearly needed, so a gas measurement box was developed within the framework of several AiF projects (AiF-Berlin) and industry partnerships. The box detects gas production with a very high level of accuracy (in the μL range). It also ensures constant operating conditions and automatic value correction in real time to provide standardised results. Repeat measurements taken at different times have shown that the error tolerance was only 2%. This level of accuracy, which was not achievable in the past, will now be exploited in partnership with a seed producer to evaluate possible modifications to an energy plant breeding programme.

Company startup. Development activities in the department have led to the first CUTEC company startup by a CUTEC employee. Dr. Christian Schröder is now marketing a range of sludge treatment methods (more information is available at www.aquen.de).

Outlook

The department will intensify its research activities to improve energy and resource efficiency, which is becoming an increasingly important issue. The research portfolio includes microbiological fuel cells to generate electricity from wastewater, more efficient nutrient and (process) water recycling techniques, improvement of biological biomass conversion technology (biomethane, bioethanol, etc.) and more efficient CO_2 capture using algae biotechnology. (si)

TRADE SHOW ACTIVITIES IN THE SPRING

"Grüne Woche" in Berlin

Mrs. Grove (right) during a technical discussion

CUTEC made an appearance at the 75th IGW show in Berlin on January 15 – 24. International Green Week is the world's largest agricultural, food and horticulture event.

CUTEC shared a stand in the Lower Saxony building with the local district council, the city of Hildesheim and Michelsen School which has a close affinity with agriculture.

Around 1600 exhibitors from 56 countries put on an impressive display. The exhibits covered a wide range including tillage, horticulture, cattle farming, fishing, hunting and much more. Regional delicacies from around the world added a special "flavour" to the show.

More than 400,000 visitors came to the grounds at the Funkturm over the course of ten days. Unfortunately not all of them found their way to the CUTEC stand, but we still had some very interesting discussions and made good contacts. CUTEC was able to explain to a large non-scientific audience the complex process of generating energy from straw based on gasification in a circulating fluidised bed. We were able to answer specific questions put forward by visitors from the Hildesheim region about the straw power CHP plant in Gronau.

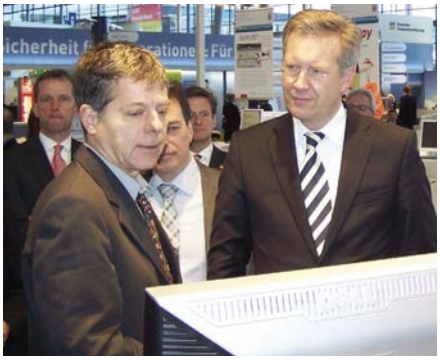
Mrs. Grove, Mr. Davidovic, Mr. Müller and Mr. Immisch were at the show on behalf of CUTEC. Our event team (Mrs. Wessels and Mr. Gründler) had everything perfectly organised, and the CUTEC presence at IGW was a genuine success. (im)

CeBIT in Hannover

The Modelling and Simulation Department once again presented one of its successful R&D projects at CeBIT. This year it was the Detectino system which has now reached the prototype stage.

The ground radar system with CI based analysis software can detect and identify utility lines buried in the ground and enter the data into existing maps. Detectino also supports 3D underground navigation.

The adaptable categoriser, the core CI element of the analysis software which was developed in house, is based on neural networks which make it possible to "correctly" interpret the hyperbolic reflections from ground radar measurements. The analysis software will be able to accommodate additional sensors (e.g. electromagnetic and seismic) as the product continues to evolve. In the current incarnation, the system can factor different types of soil and underground moisture into the analysis, which greatly increases the reliability and positional accuracy of line detection compared to conventional systems. The response to the system on display was more than satisfactory. The team at the show welcomed Lower Saxony Minister President Christian Wulff at the stand along with several State Ministers and numerous companies which showed an interest in the system, giving us the opportunity to establish initial business contacts. (reu)



Prof. Reuter (left) explains how Detectino works to Minister President Christian Wulff (right)

WERNER GRÜBMEYER
A true friend and active supporter of CUTEC for the past 20 years

CUTEC celebrated its 20th anniversary at the end of March, and now is a good time to reflect on 20 years of history. If we could watch a film of the past 20 years, one individual would appear again and again, namely Werner Grübmeyer. Despite the fact that he never worked directly for CUTEC, he has made a major contribution to the institute over the past 20 years. Not only was he co-initiator of the institute (Prof. Kurt Leschonski and Werner Grübmeyer are the spiritual founders of CUTEC), but it is also thanks to him that in spite of considerable political opposition this unique institution is now located in Clausthal-Zellerfeld. His active involvement in the political arena and his exceptional perseverance were part of the reason why CUTEC was able to move into a new building in 1995. In the early days, he provided valuable advice to our first Managing Director Prof. Leschonski, and he continues to advise Prof. Carlowitz, our current Managing Director, despite that fact that he retired a long time ago. Mr. Grübmeyer has an excellent knowledge of state and national politics, and he has a seemingly endless pool of contacts at all levels, which he has built up and maintained over the course of many years. In his speech at the Order of Merit award ceremony for Werner Grübmeyer in 1997, Former German Vice-Chancellor Frank-Walter Steinmeier described his impression: "In the many meetings which we have had, I was always deeply impressed by your perseverance and charm as you sought to achieve your goals and represent your interests. I have no doubt that this combination of traits is the real secret to your personal success." That says it all. We pay our respects and extend our sincere thanks to Werner Grübmeyer. (he)

DO YOU KNOW HOW IT ALL GOT STARTED?

Summary of an article with appeared in the 15-year anniversary issue

(Explanatory note: reprint of the text that was written by Mrs. Vollbrecht for CUTEC's 15th anniversary. (...) indicates places where text has been slightly abridged.)
Mrs. Gerda Vollbrecht worked for 10 years as Business Manager and made a significant contribution to the development of CUTEC. Her excellent administrative skills were a major asset to the institute's Managing Director and staff.

CUTEC came into being when the Articles of Association were signed on March 28, 1990. Consolidation of research activities at a single location appeared to be the only viable option, because researchers need their own dedicated institutes to meet their teaching and research commitments. An attempt had to be made to set up a research institute for interdisciplinary applications-oriented research in the field of environmental technology. (...)

At the time, the Lower Saxony Ministry of Economics, Technology and Transport had responsibility for this area of practical applied research (ownership was subsequently passed on to the Ministry of Science and Culture). The Ministry decided that a limited liability company was the best solution. CUTEC was set up as an extramural research institution with Lower Saxony as the sole 100% owner. Professor Kurt Leschonski, Director of the Institute for Mechanical and Environmental Process Technology at TU CLausthal, was appointed as Managing Director alongside of his regular duties. Ever since CUTEC was founded, the various departments have been working together on an interdisciplinary basis to carry out research and investigation projects. (...)

Mrs. Helga Schuchardt (left, Lower Saxony Minsiter of Science and Culture from 1990 to 1998) and architect Mr. Husemann at the laying of the foundation stone at CUTEC on May 18, 1993

Hinrich Swieter, Finance Minister for Lower Saxony from 1990 to 1996, gave the keynote speech at the topping-out ceremony at CUTEC on December 3, 1993

Following the signature of a partnership agreement with TU Clausthal in August 1991 (where the professors who initiated the request to set up CUTEC were working), the researchers had sufficient opportunity to carry out their activities until the expected construction of a new building. Starting in 1990, Lower Saxony provided funding for a number of research, engineering and administrative employers (the latter worked in rented premises).

Eventually, Lower Saxony made a firm commitment to provide DM 33 million in funding for a new building plus DM 12 for initial outfitting. (...)

Despite the fact that a detailed estimate of the construction costs had been developed, construction prices had increased dramatically by the time the bids were opened, and the institute was facing a shortfall of DM 12 million. As a matter of principle, Professor Leschonski and Werner Siemers, who provided advice and support on construction issues, were determined that CUTEC would stay within the limits of the DM45 million that had been allocated. Working together with the architect Mr. Husemann and the engineering consultants, the two of them succeeded in keeping construction costs within the DM 35 million budget. (..)

The CUTEC building shortly before completion in the summer of 1994

The new building was ready for occupancy right on schedule on December 31, 1994. According to the Articles of Association, the scientific directors of each department, who had to be faculty members at TU Clausthal, were organised into a Directorate which had responsibility for providing scientific advice to the management team and ensuring that the departments work together on a multi-disciplinary basis. The Managing Director was the Chairman of the Directorate, and he also presided over weekly meetings where senior staff members presented progress reports, giving Prof. Leschonski access to all of the vital information streams. Despite the fact that

Continuation

DO YOU KNOW HOW IT ALL GOT STARTED?

he had staff working at ten different sites, the Managing Director was able to carry out his management and leadership responsibilities with the support of a very committed Scientific Advisory Board and an alert and fair Supervisory Board.

The Business Administration, IT and PR departments moved into the new building on December 12, 1994, as the leases for their rented premises expired on December 31, 1994. Some time afterwards, the Process and Environmental Analysis Department moved in, and over the course of the next few months the rest of the scientific departments which had been working in university premises also moved. When the Thermal Department's elaborate research equipment was dismantled and re-assembled at the new site in mid-1996, new building was fully operational.

Naturally celebrations were in order. The building with is excellent facilities is very appealing, and it generated a lot of interest on the part of the academic and political communities and the general pubic which had the opportunity to get a first-hand impression on Open Day. Prior to the official opening ceremony in July 1995, then Minister President Gerhard Schröder selected CUTEC as the venue for presentation of the 1994 Lower Saxony Prizes in May 1995. (...)
Minister President Gerhard Schröder took the opportunity at the official opening ceremony in July 1995 to give a remarkable speech on environmental technology. (...)

Prof. Leschonski (right) with Gerhard Schröder (left, then Lower Saxony Minister President) at the official opening of the new CUTEC building in July 1995

CUTEC showcased the Expo project "The Future of Waste Treatment" in Clausthal-Zellerfeld in 2000

The new building offered excellent working conditions and job security to around 50 employees, creating ideal conditions for interdisciplinary research. The personal and professional development of the young scientists allowed the university faculty members, who were members of the Directorate and were heavily involved in the start up phase, to gradually reduce their level of involvement.

Naturally the main priority was completion of research and investigation projects and active participation at scientific symposiums, but there was also other highly interesting work to do. The "The Future of Waste Treatment" project at EXPO 2000 was well received. The project lasted four months and was highly successful. Exhibitions, guided tours and lectures at the CUTEC Institute attracted considerable attention from the general public.

Professor Leschonski retired on March 31, 1999 at the age of 69. TU Clausthal and CUTEC jointly appointed Professor Otto Carlowitz as Managing Director of CUTEC on April 1, 2000. Professor Leschonski had every reason to be assured as he handed over his life's work. Members of the Lower Saxony government and former colleagues highlighted Professor Leschonski's accomplishments at the farewell ceremony in the lecture hall at CUTEC on June 30, 1999. It was very pleasing for Professor Leschonski to witness the excellent progress which the institute has made under the new management. Professor Leschonski passed away on March 21, 2002 at the age of 71. The 15th anniversary would have been a fitting occasion for him to reflect on the origin and realisation of a great idea.

(vo/he)

Prof. Leschonski (at the lectern) during a farewell colloquium in 2000

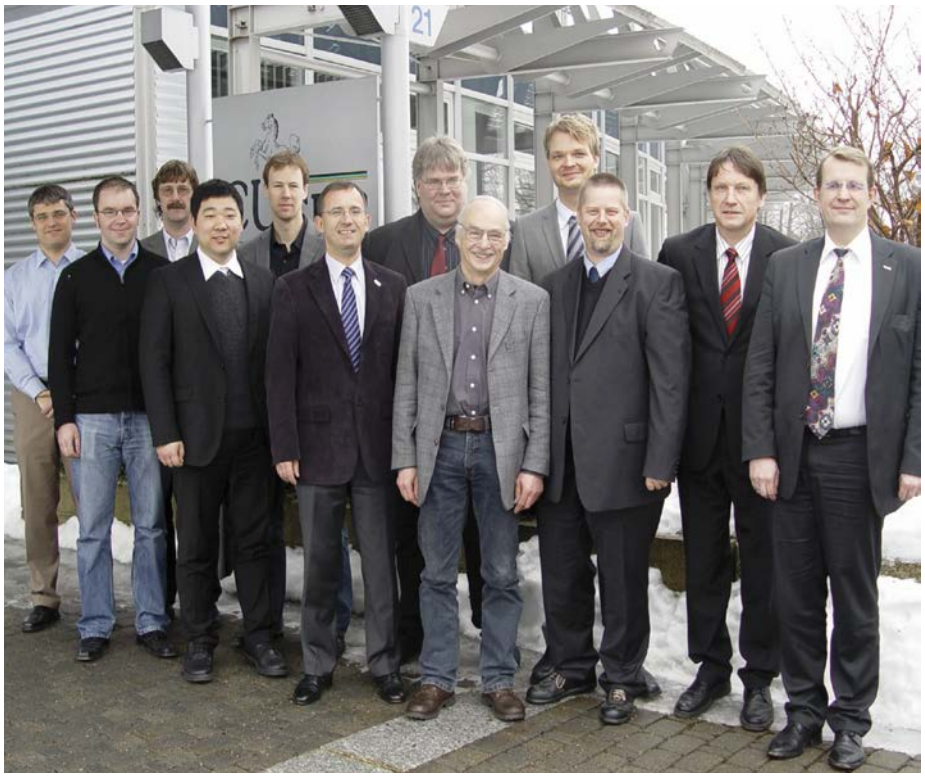
APPLIED RESEARCH ON MARKET INTRODUCTION OF SOFC TECHNOLOGY

Back in 2005 – 2007, CUTEC joined forces with H.C. Starck and the Electrical Engineering and Metallurgical Institutes at TU Clausthal to develop an initial SOFC demonstrator to highlight the potential of SOFC technology. CUTEC News reported on these developments in March/April 2005.

Based on the experience gained at the time and subsequent advances in the power density, lifetime, cost, maintainability and repairability of SOFC stacks, work will now continue to develop, study and critically assess different engineering strategies as a major milestone on the road to industrial-scale system development of marketable, high efficiency SOFC-based power generation solutions. Lower Saxony and the EU will be providing €1.1 million in funding over a three year period. Including internal funding and substantial support from industry, a total of €1.5 million will be available for the project.

A Lower Saxony Research Alliance was formed on March 1, 2010, which includes the key players from the scientific and business communities. During the course of the project, seven institutes at the universities of Braunschweig, Clausthal, Hannover and Osnabrück along with CUTEC plan to build an SOFC system that has a number of innovative features compared to current state-of-the-art solutions:

- compact, lightweight, portable design based on planar design and stacking of the main modules for the small power range (300 Wel); little need for connecting elements such as pipes; positioning of the functional groups to minimise transmission heat losses
- utilisation of internal system heat for endothermic reforming and for air and combustion gas pre-heating based on anode off-gas recirculation to significantly increase electrical efficiency
- reduced use of sensors to minimize internal consumption; this is accomplished through model-based operational management and implementation of an observer (estimator) which predicts non-measurable parameters (states) using a model derived from known input and measurement variables; utilisation of the propane bottle pressure to drive the anode off-gas recycling (no electrically powered pump unit)
- use of established industrial fabrication, joining and production techniques (laser welding/cutting, EDM) to simplify transfer of the conceptual design



Launch of the research alliance – development team at a preliminary meeting in February 2010 in Clausthal

The photo above shows the research team at a preliminary meeting in Clausthal.

The following companies in Lower Saxony

- BMA, Braunschweigische Maschinenbauanstalt AG, Braunschweig
- EcoEnergy Gesellschaft für Energie- und Umwelttechnik mbH, Walkenried
- Elster GmbH, Osnabrück
- EWE AG, Oldenburg
- GEA Ecoflex GmbH, Sarstedt
- H.C. Starck GmbH, Goslar
- LASER on demand GmbH, Burgwedel
- SIEB & MEYER AG, Lüneburg
- Solvis GmbH & Co KG, Braunschweig

are providing valuable support. Staxera GmbH, Dresden, is supplying the SOFC stacks for use in the SOFC cells of H.C. Starck GmbH. A meeting is arranged to bring the researchers and companies involved together.

The partners are building the system to demonstrate the basic feasibility of the technology to users in Lower Saxony and to foster knowledge transfer.

Based on the system, suppliers of the balance-of-plant components (e.g. fans, valves, instrumentation & control equipment, burners, insulation material, etc.) will be able to define and develop suitable products, thereby increasing the economic impact of fuel cell market introduction. The industrial partners involved in the project intend to continue working on the system and individual components to proceed to the prototype stage, and they plan to take responsibility for subsequent market introduction. Scientific issues and specific adaptation will be addressed in collaboration with the project partners.

The research and business partners will combine forces to form a highly effective consortium for market introduction of SOFC technology. (di)

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CLAUSTHAL ENERGY PARK – COLLABORATION WITH TU CLAUSTHAL

Dr. Wehrmann in the CHP room at the Clausthal Energy Park during a TV interview

from renewable resources for the building complex at the CUTEC institute. IEE has responsibility for total electricity supply at the site including autonomous operation. IEVB played a leading role in the development of the infrastructure, particularly the experimental thermal network. Working together, the partners developed a control system with integrated energy management which is designed to determine the best combination of power generation systems and to make the best possible use of them.

A large experimental network was installed to support studies on electrical and thermal distribution systems. This was one of the reasons why CUTEC and IEE have been able to run their own subprojects since 2006 within the framework of the Lower Saxony Energy Research Association (FEN). During the first phase of the project, the partners worked together on a subproject to evaluate the operational stability of the micro grid at the Clausthal Energy Park. Initially, the researchers assessed the stability of the experimental electrical grid. When the decision was taken at FEN to further investigate and optimise heat extraction from CHP plants, the CHP system at the Energy Park was upgraded to a CHCP system through the addition of an absorption chiller. Since 2009, CUTEC has been working on a separate CHCP project with absorption chillers, which is focused exclusively on the thermal section of the experimental grid at the Energy Park. Working under the FEN umbrella, IEE is continuing its stability investigations on the experimental electricity grid in a follow-on subproject to test innovative power converter systems.

In joint partnership with TU Clausthal and IEVB, CUTEC also completed a project to integrate the Jerstedt/Goslar biogas plant into the Clausthal Energy Park. The Stirling motor CHP was run with biogas under real-life conditions at a biogas plant during the course of this project. (sen)

Meeting with project partners: CUTEC (Mr Siemers, right), IEE (Dr. Wehrmann, 2nd from right) and IEVB (Mr. Hillebrecht, left and Mr. Harnaut, 2nd from left)

EVENTS

CUTEC presentation at IFAT 2010 in Munich on September 13 – 17, 2010 in Hall B2, Stand 219

We look forward to seeing you there.

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WORKERS COUNCIL REPORT

In the emotive public debate on Workers Councils, people are normally divided into two camps. Some argue that a company is not a grass-roots democratic institution whereas other see the Workers Council as a means of eliminating capitalistic exploitation in its most extreme forms. Besides these oversimplified and polarising arguments, more thoughtful views are being expressed such as: "a highly committed Workers Council contributes to the success of a company". When workers have an institution which represents their interests and their reasonable expectations, they are much more likely to identify with the company. There is a close relationship between improved company performance and job security/creation.

Especially at companies that are highly dependent on the intellectual contribution of each employee, it is vitally important that the employees can keep a clear head. The Workers Council, which represents the interests of the workforce, plays an indispensible role in creating a positive company culture, and this was recognised early on at CUTEC. The first Workers Council with five members was set up in 1994. Right from the start, the members of the Council invested their time on a voluntary basis outside of regular working hours and all organisational units were represented. Since Prof. Carlowitz was appointed Managing Director in 2000, the Workers Council has been more closely involved in the company development process. The Chairman of the Workers Council is the head of the Steering Group which makes an active contribution to the development process. The Steering Group developed and supported a number of beneficial programmes including:

- development and implementation of a behaviour code
- questionnaire campaign to identify opportunities for optimisation and to define/implement the associated action plan
- doctorate agreement to support young scientists
- qualification programme to cover resource needs with in-house staff
- trainee programme
- establishment of a Strategic Board
- development of needs-based work-time agreements

We would like to take this opportunity to thank Prof. Carlowitz for his trust, confidence and commitment. The highly-motivated CUTEC team provides fertile ground for the sustained success of the company. The fact that the company has grown to the size where the Workers Council now has seven members reflects this contribution. Anyone who knows the CUTEC team has no doubt that everyone will continue to maintain their level of dedication and commitment. There is good reason why other companies occasionally succeed in recruiting CUTEC staff (unfortunately for us). (ze)

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SUSTAINABILITY MANAGEMENT CLUSTER

- network creation and management

CNM has played an active role in the market right from the start, and it is fully focused on achieving its operational goals. Its success is reflected in its ability to reach revenue targets. The priority at the moment and for the foreseeable future is metal resource efficiency. (Please refer to the feature article Dezincing II on Page 17.) We are particularly pleased to have established a close working relationship with Prof. Gock from the TU Clausthal Waste Treatment and Landfill Technology Institute. Our team members Britta Kragert, Sven Schulze, Andreas Sauter and Torsten Zeller have a mix of scientific, engineering and business skills. We are looking forward to taking on future challenges and know that we will put in a "sustained" effort (ze)

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DEZINCING STEEL SCRAP II

The complete unit is made largely of acid-resistant polypropylene. The alternative to polypropylene would have been stainless steel, but this would have driven up the cost considerably.

The individual modules were connected by pipe to the supply tanks as the installation work proceeded. A scrap metal feeder consisting of an electromagnet and a vibrating conveyor was integrated, and provision was made for heating the acid with energy from the CO2-neutral CUTEC Energy Park. The CUTEC neutralisation system can be used for disposing of the rinse water.

Fig. 4: Finished dezincing unit

At the second project meeting on March 29, 2010, the dezincing unit was officially put into operation by the project partners and representatives of the Jülich/Berlin agency. Over the course of the next one and a half years, intensive research can now proceed in order to optimise the dezincing process for steel scrap and to gather valuable insights for the construction of an industrial-scale demonstration unit. The goal is to close the material recycling loop and ensure sustainable use of existing resources.

We would like to take this opportunity to thank the Federal Ministry of Education and Research and the Jülich/Berlin agency for their commitment in making this project possible. We would also like to express our appreciation to our project partners and the staff at CUTEC for their contributions to the successful construction of the dezincing unit. (sr/ze)